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(Reaffirmed 2001)

Indian Standard

SPECIFICATION FOR DENTAL PORCELAIN

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SPECIFICATION FOR DENTAL PORCELAIN

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Indian Standard

SPECIFICATION FOR DENTAL PORCELAIN

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 2 June 1977, after the draft finalized by the Dental Materials Sectional Committee had been approved by the Chemical Division Council.

0.2 Dental porcelain is used in the construction of artificial teeth, for the fabrication of jacket crowns and inlays and as a veneer over cast metal crowns. It is basically a fine ceramic powder, pigmented to produce the colour and shade of a human tooth.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS :2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the requirements and the methods of sampling and test for dental porcelain, to be used for all-porcelain jacket crown and inlay restorations.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 7348 (Part III)-1975† and the following shall apply.

2.1.1 *Clinical Crown* -That part of a tooth that is exposed in oral cavity.

2.1.2 *Condensation* -Any process by which an unfired dental porcelain paste is compacted.

2.1.3 *Core Porcelain* -An opaque dental porcelain that provides a mechanically strong and optically uniform basis for a jacket-crown or inlay restoration.

*Rules for rounding off numerical values (revised).

†Glossary of terms relating to dentistry: Part III Dental materials,

2.1.4 Degree of Fusion

2.1.4.1 *High biscuit*—The fusion attained when firing shrinkage is just complete.

2.1.4.2 *Medium glaze* — The fusion attained when the glaze is clinically and aesthetically acceptable.

2.1.5 *Modelling Fluid*—A liquid (other than water) with which a dental porcelain may be mixed prior to condensation.

2.1.6 *Upper Transformation Temperature* — The higher of the two temperatures, at which, in the determination of thermal expansion coefficient of a dental porcelain, the slope of the graph of linear expansion against temperature changes fairly sharply.

3. TYPES

3.1 Types and Their Colours — Dental porcelain shall be divided into types according to their intended use and, if a colour coding system is used to identify the type of a powder, the appropriate colour given below shall be used:

<i>Type</i>	<i>Colour</i>
Core porcelains	Yellow or none
Dentine/body porcelains	Pink
Enamel porcelains	Blue
Neck material	Green
Transparent material	None
Concentrate material	None
Add-on material	None
Glaze material	None

3.1.1 Colour coding shall not involve the addition to the powder of more than 0.1 percent by mass of organic material.

4. REQUIREMENTS

4.1 Description — The material shall be in the form of a powder.

4.2 Freedom from Extraneous Materials — Dental porcelain powder shall be free from extraneous materials. When a dental porcelain is used in accordance with the manufacturer's instructions, the concentration in the fired porcelain of any irritant or toxic ingredients shall not be high enough to cause irritation or toxic reaction.

4.3 Uniform Dispersion —Both the metal oxide pigment(s) used to produce the fired colour of a dental porcelain and any dye(s) used for type identification shall be uniformly dispersed throughout the dental porcelain

powder, and no segregation of the pigment(s) or dye(s) shall take place when the powder is mixed as prescribed in A-1.3.

4.4 Mixing and Condensing — When mixed as prescribed in A-1.3 with water or a suitable modelling fluid, a dental porcelain powder shall not form lumps or granules. The paste so formed shall be suitable for the hand-building (by conventional dental laboratory techniques) of a **jacket-crown** or inlay restoration, and when the paste is condensed as in A-1.4, it shall not crack or crumble during the drying cycle recommended by the manufacturer.

4.5 Particle Size -The material shall be of such a particle size that when tested as prescribed in A-2 no material is retained on **75-micron** IS Sieve* and the amount retained on **53-micron** IS Sieve* does not exceed 10 percent (m/m).

4.6 The material shall also comply with the requirements given in Table 1.

5. PACKING AND MARKING

5.1 Packing — The material shall be packed in sealed containers that shall not contaminate **or permit** contamination of the contents. Containers shall be securely closed.

5.2 Marking-Each container shall bear legibly and indelibly the following information:

- a) Name and type of the material;
- b) Name of the manufacturer and his recognized trade-mark, if any;
- c) Shade;
- d) Net mass; and
- e) Batch number.

‘5.2.1 *Manufacturer's Instructions* — When so required by the purchaser, the dental porcelain powder shall be accompanied by instructions (supplied by the manufacturer) that include the following information:

- a) A time-temperature cycle for drying the condensed porcelain;
- b) A time-temperature cycle for the firing schedule (including the final temperature, the time it should be held, and the rate of heating) and, in the case of a vacuum firing porcelain, the level, duration and time of application of vacuum;
- c) The glazing temperature;

*See IS : 460-1962 Specification for test sieves (revised).

- d) A warning regarding the potential health hazards presented by prolonged exposure to dusts containing a high concentration of quartz, cristobalite or other siliceous material(s) or uranium; and
- e) If the powder contains uranium in any form, a warning to the effect that the powder shall not be swallowed or allowed to come into contact with a brush or an instrument that may be introduced into the mouth.

TABLE 1 REQUIREMENTS FOR DENTAL PORCELAIN

(Clause 4.6)

SL No.	CHARACTERISTIC	REQUIREMENT			METHOD OF TEST. REF TO CL No. IN APPENDIX A
		Core	Dentine/Body	Enamel	
(1)	(2)	(3)	(4)	(5)	(6)
i)	Volumetric firing shrinkage, percent, <i>Max</i>	40	40	40	A-3
ii)	Linear firing shrinkage, percent, <i>Max</i>	16	16	16	A-3
iii)	Fired porosity, percent, <i>Max</i> :				A-4
	a) Air	3	3	3	
	b) Vacuum	3	0.5	0.5	
iv)	Flexural strength, N/mm ² , <i>Min</i>	100	55	50	A-5
v)	Resistance to pyroplastic flows:				A-6
	a) Decrease in height after 2 minutes, percent	-4 to +1	0 to +10	-0 to +10	
	b) Decrease in height after 16 minutes, percent	-4 to +1	\$4 to \$15	+4 to +15	
vi)	Chemical solubility, loss in mass, percent, <i>Max</i>	0.5	0.05	0.05	A-7
vii)	Resistance to staining: visible stains on any surface	Nil	Nil	Nil	A-8

5.2.2 The containers may also be marked with the IS1 Certification Mark.

NOTE -The use of the IS1 Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The IS1 Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by IS1 and operated by the producer. IS1 marked products are also continuously checked by IS1 for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the IS1 Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

6. SAMPLING

6.1 The method of preparing samples of the material and the criteria for conformity shall be as given in Appendix B or as agreed to between the purchaser and the supplier.

7. TEST METHODS

7.1 Tests shall be carried out according to methods prescribed in Appendix A.

7.2 Quality of Reagents -Unless specified otherwise, pure chemicals and distilled water (see IS :1070-1977*) shall be employed in tests.

NOTE — ' Pure chemicals ' shall mean chemicals that do not contain impurities which affect the results of analysis.

APPENDIX A

(*Clauses 4 3 to 4.6 and 7.1, and Table 1*)

METHODS OF TEST FOR DENTAL PORCELAIN

A-1. GENERAL

A-1.1 Ambient Conditions — Carry out all mixing of the porcelain paste during the preparation of test specimens and testing in an atmosphere maintained at $27 \pm 2^{\circ}\text{C}$.

A-1.2 Apparatus for Mixing — Use the following apparatus for mixing dental porcelain powder with water or a modelling fluid:

- a) A glass slab or a mixing palette;
- b) A spatula made from a material (other than a metal) that is not abraded by the dental porcelain powder (glass is recommended).

*Specification for water for general laboratory use (second revision).

A-1.3 Method of Mixing — Combine the mixing liquid and the porcelain powder. Avoid vigorous mixing which will tend to incorporate air bubbles with the paste, and both during and after mixing, examine for compliance with 4.2 and 4.3. Remove the **excess liquid** by blotting with an absorbent tissue.

A-1.4 Condensation

A-1.4.1 Apparatus

A-1.4.1.1 Mould — an open multipart mould from which the condensed specimen may be removed without distortion.

A-1.4.1.2 Vibration system — shown in Fig. 1, consisting essentially of:

- a) a 50 to 60 Hz sine-wave generator with a variable output amplitude,
- b) a transducer, and
- c) a **mould-carrier** that is pivoted at one end and is so spring-loaded that the mould is subjected to an impact in each cycle of vibration.

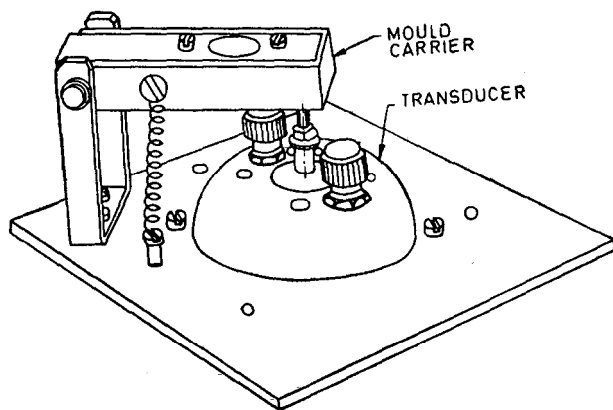


FIG. 1 MOULD VIBRATOR ASSEMBLY

A-1.4.2 Procedure — Attach a mould firmly to the mould carrier, overfill it with dental porcelain paste and vibrate. When excess liquid appears at the free surface of the specimen, place a paper tissue (or similar absorbent material) on the surface of the specimen, and remove the excess liquid continuously by replacing the tissue as soon as it becomes saturated with liquid, Continue vibration and absorption until no further liquid

can be removed and then level the free surface of the condensed specimen by means of a suitable instrument (a **bevelled** glass microscope slide is ideal for this purpose). After removing it from the mould, place the specimen on a firing tray, dry it in accordance with the manufacturer's instructions (see 5.2.1) and check for compliance with 4.4.

A-1.5 Firing

A-1.5.0 *General* - Unless specified otherwise, fire the porcelain specimens in accordance with the manufacturer's recommended firing schedule (see 5.2.1).

A-1.5.1 *Procedure* — Position the specimens in the furnace so that they will be uniformly fired, and place them on a substrate to which they will not adhere and from which there will be no material pick up. (Asbestos sheet or board dusted with α -alumina or a lightly sintered α -alumina sheet is recommended as a suitable substrate.)

A-2. DETERMINATION OF PARTICLE SIZE

A-2.1 Apparatus

A-2.1.1 *Sieves* — **75-micron** and **53-micron** IS Sieves (see IS : 460-1962*).

A-2.1.2 *Oven* — capable of maintaining a temperature of $40 \pm 2^\circ\text{C}$.

A-2.2 *Procedure* - Weigh accurately about 10 g of the material and place it in a **250-ml** conical flask. Add 150 ml of water. Stopper the flask and shake for 2 minutes. Transfer the suspension to a **75-micron** IS Sieve nested on the **53-micron** IS Sieve and wash with water. When all the powder has been washed through the **75-micron** sieve (or when no further powder can be washed through it), separate the sieves and continue washing the residue on the **53-micron** sieve until the washings are clear.

A-2.3 *Calculation* - Dry the sieve and residue to constant mass at $40 \pm 2^\circ\text{C}$, and record the residue retained on each sieve as a percentage of the mass of the powder used.

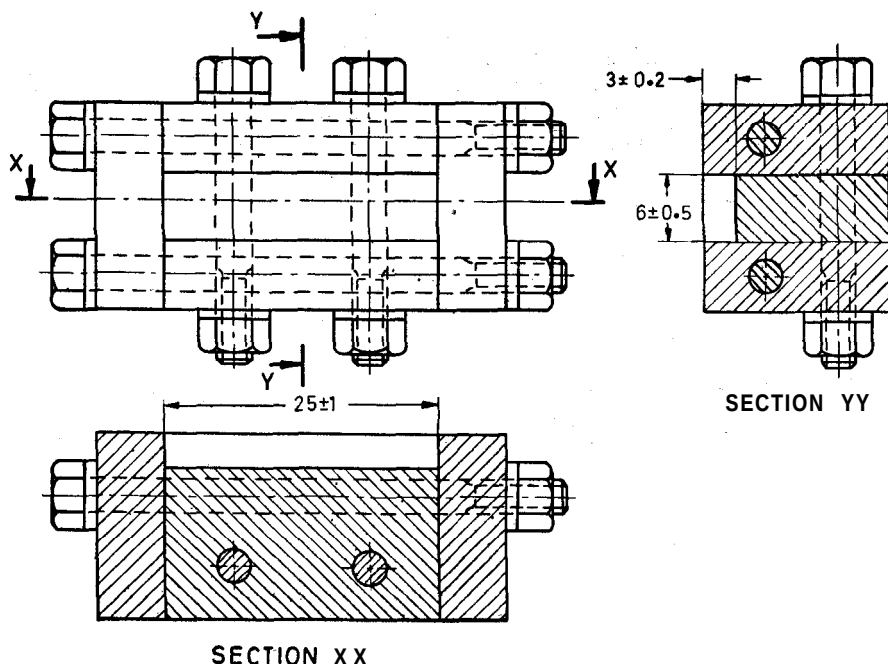
A-3. DETERMINATION OF FIRING SHRINKAGE

A-3.1 Apparatus

A-3.1.1 *Mould* — as shown in Fig. 2 having a cavity of nominal size $25.0 \times 6.0 \times 3.0$ mm.

A-3.1.2 *Micrometer* — reading to 0.01 mm.

*Specification for test sieves (revised).



All dimensions in millimetres.

FIG. 2 MOULD FOR USE IN FIRING SHRINKAGE, FLEXURAL STRENGTH AND THERMAL EXPANSION TESTS

A-3.2 Preparation of Test Specimens — Using 10 g of the material and the mould, prepare 10 specimens, firing each specimen to a high biscuit degree of fusion.

A-3.3 Procedure — Determine, to an accuracy of ± 0.01 mm, the dimensions of the mould cavity and the length (L_s) of each fired specimen. Determine the mass of each fired specimen (a) in air (M_1); and (b) in water (M_2) that is in equilibrium with the ambient temperature ($27 \pm 2^\circ\text{C}$). Retain the specimens for the test given in A-5.

A-3.4 Calculation — Calculate:

a) the volume, V_m , of the mould cavity as follows:

$$V_m = L_m \times W_m \times D_m$$

where

L_m = length in mm of the cavity,
 W_m = width in mm of the cavity, and
 D_m = depth in mm of the cavity.

- b) The volume, V_s , of each fired specimen as follows:

$$V_s = \frac{(M_1 - M_2)}{d}$$

where

M_1 = mass in g in air of the specimen,

M_2 = mass in g in water of the specimen, and

d = density of water at the temperature of the test.

- c) The volumetric firing shrinkage, percent by mass, V_s of each fired specimen as follows:

$$V_s, \text{ percent} = \frac{(V_m - V_s)}{V_m} \times 100$$

- d) Average volumetric firing shrinkage, namely the mean of the individual results obtained in (c) above.

NOTE — Discard any individual value that differs by more than 10 percent from the mean, and ensure that the final test result is the mean of the results on at least eight specimens by testing additional specimens, when necessary.

- e) The linear firing shrinkage, L_s of each specimen as follows:

$$L_s, \text{ percent} = \left(\frac{L_m - L_s}{L_m} \right) \times 100$$

- f) The average linear firing shrinkage, namely the mean of the individual test results obtained in (e) above.

NOTE — See Note under (d).

A-4. DETERMINATION OF FIRED POROSITY

A-4.1 Apparatus

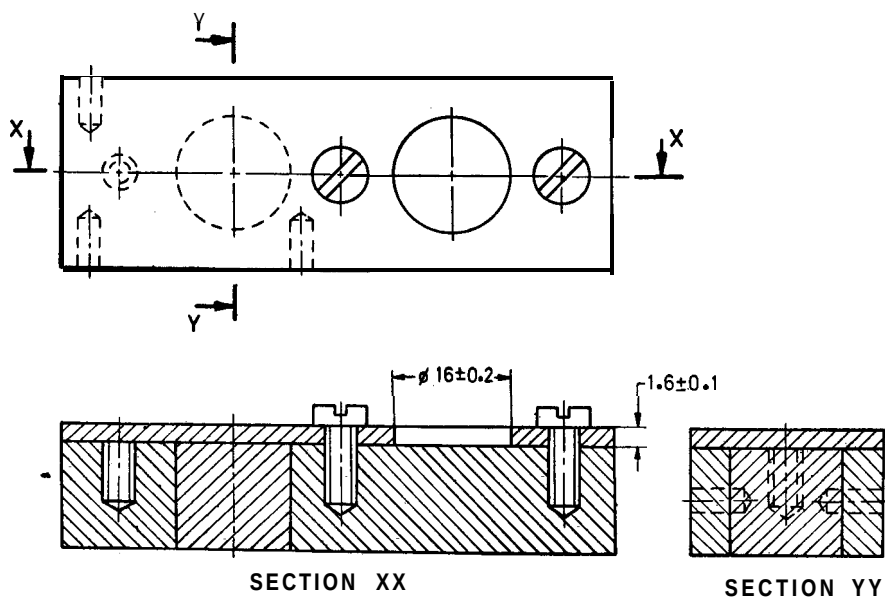
A-4.1.1 Equipment for the production of flat parallel-sided specimens by grinding.

A-4.1.2 *Mould* -as shown in Fig. 3 and having a circular cavity of diameter 16.0 ± 0.2 mm and depth 1.6 ± 0.1 mm.

A-4.1.3 *Optical Microscope* -with an automatic point-counting attachment.

A-4.1.4 Equipment for the Preparation of Polished Sections

A-4.2 Preparation of Test Specimens — Using 5 g of the material and the mould, prepare three specimens firing each specimen to a high biscuit degree of fusion. Then prepare a polished section of each specimen, ensuring that the section is approximately parallel to, and approximately



All dimensions in millimetres.

FIG. 3 MOULD FOR USE IN FIRED POROSITY AND CHEMICAL SOLUBILITY TESTS

midway between, the flat faces of the specimen. Finally grind the surfaces of the test pieces on loose wet 600 grit silicon carbide powder on a glass plate.

A-4.3 Procedure — Using the optical microscope, examine each specimen (under reflected light) at a magnification of $\times 250$, and carry out a 'point count' of pores in the polished section, counting not less than 1 000 points uniformly distributed over an area of at least 8×8 mm.

A-4.4 Calculation

$$\text{Porosity in the plane of each section, percentage} = \frac{\text{Number of pores counted}}{\text{Number of points counted}} \times 100$$

A-5. DETERMINATION OF FLEXURAL STRENGTH

A-5.1 Apparatus

A-5.1.1 Equipment — for the production of flat parallel-sided specimens by grinding.

A-5.1.2 *Flexural Strength Testing Machine* — having a span between bearers of 12 to 15 mm, bearing surfaces of diameter 1.6 mm, and a rate of application of load not exceeding 0.5 N s^{-1} .

A-5.2 **Preparation of Test Specimens** — Dry the ten specimens retained in terms of A-3.3, and so grind each specimen as to produce a rectangular test piece of width 5.0 ± 0.25 mm, thickness 1.0 ± 0.05 mm and length at least 20 mm. Then grind the surfaces of the test piece on loose wet 320 grit silicon carbide powder on a glass plate. Ensure that opposing faces of the test pieces are flat and parallel to within 0.01 mm. Thoroughly clean the test pieces, ensuring that all traces of grinding debris are removed, and then fire them to a medium glaze degree of fusion. In the case of core type porcelain, fire the ground test pieces to the manufacturer's recommended firing schedule for dentine porcelains before submitting them to the glaze firing.

A-5.3 **Procedure** — Measure the cross sectional dimensions of each test piece to the nearest 0.01 mm. Then place a test piece centrally on the bearers of the testing machine, so that the load will be applied to a 5 mm wide face along a line perpendicular to the long axis of the test piece, and determine to the nearest 0.1 N the load required to break it. Test remaining test pieces in the same way and retain one of the broken pieces for the test described in A-S.

A-5.4 Calculation

$$\text{Flexural strength, N/mm}^2 = \frac{3 WL}{2 b d^2}$$

where

W = breaking load in N,

L = test span in mm (centre-to-centre distance between bearers),

b = thickness in mm of the test piece, and

d = width in mm of the test piece.

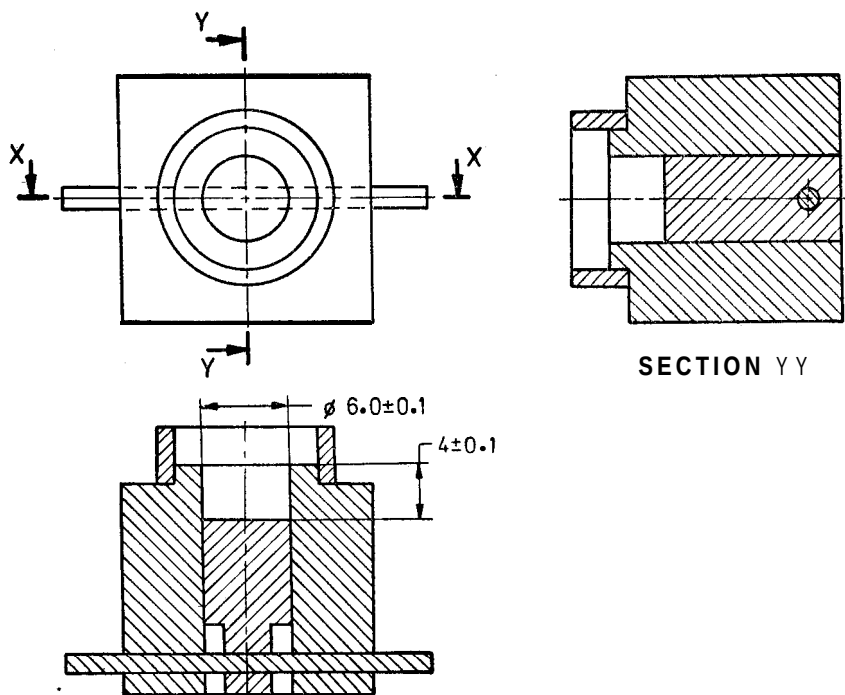
A-6. DETERMINATION OF PYROPLASTICITY

A-6.1 Apparatus

A-6.1.1 *Mould* — as shown in Fig. 4 and having a circular cavity of diameter 6.0 ± 0.1 mm and depth 4.0 ± 0.1 mm.

A-6.1.2 *Pure Platinum Foil* — of thickness 0.025 mm.

A-6.1.3 *Micrometer* — reading to 0.01 mm.

**SECTION XX**

Material : Brass or steel rod.

All dimensions in millimetres.

FIG. 4 MOULD FOR USE IN PYROPLASTICITY TEST

A-6.2 Preparation of Test Specimens — Using 5 g of the material and the mould, prepare six specimens firing them to a high biscuit degree of fusion. Check visually that the specimens are uniformly fired, the end faces are flat and parallel, the cylindrical faces are plane, and no edge is chipped. Replace any specimen that does not comply with these requirements. Using the hand micrometer, measure the height and diameter of each specimen. Replace any specimen whose aspect ratio (that is diameter/height) is outside the range 1.45 to 1.55.

A-6.3 Procedure

A-6.3.1 Place the six specimens on a flat sheet of platinum foil, leaving a gap of at least 3 mm between specimens. Fire the specimens in air

(at atmospheric pressure) to the manufacturer's recommended final firing temperature, using the recommended rate of rise of temperature. Maintain the final temperature for 2 minutes, then cool the specimens to room temperature, and measure and record the height of each specimen.

A-6.3.2 Refire the specimens as in A-6.3.1 but maintain the final firing temperature for 14 minutes. Cool and again measure and record the height of each specimen.

NOTE — If the specimens adhere to the platinum foil, measure their heights '*in situ*' (that is including the platinum foil), and obtain the actual specimen heights by subtracting the thickness of the foil.

A-7. DETERMINATION OF CHEMICAL SOLUBILITY

A-7.1 Reagents

A-7.1.1 Acetic Acid Solution — 4 percent (*v/v*) solution of acetic acid in water.

A-7.2 Apparatus

A-7.2.1 Mould — See **A-4.1.2**.

A-7.2.2 Extraction Apparatus — a reflux-condenser type, consisting of:

- a) One 50 ml-flask;
- b) 200 mm-condenser; and
- c) 20 × 55 mm clean, dry, sintered glass bottomed thimble (porosity 2).

A-7.2.3 Oven — capable of maintaining a temperature of $150 \pm 3^{\circ}\text{C}$.

A-7.3 Preparation of Test Specimens — Using 10 g of the material and the mould, prepare specimens (with an aggregate mass of at least 5 g) firing them to a medium glaze degree of fusion.

A-7.4 Procedure — Place the specimens in the sintered-glass bottomed thimble and weigh them to the nearest 0.1 mg. Place the thimble in the extraction apparatus, and extract the specimens with acetic acid solution by refluxing for 16 hours. Wash the specimens (in the thimble) with water, dry them at $150 \pm 3^{\circ}\text{C}$ for 4 hours, and reweigh the specimens and thimble.

A-7.5 Calculation — Calculate the percentage loss in mass of the specimens.

A-8. TEST FOR RESISTANCE TO STAINING

A-8.1 Reagents

A-8.1.1 Staining Solution — a saturated solution of methylene blue in ethyl alcohol.

A-8.2 Apparatus -A small vial of length approximately 20 mm and diameter approximately 10 mm.

A-8.3 Preparation of Test Specimens — Using loose wet 320 grit silicon carbide powder on a glass plate, grind the glaze off one large face of the piece of broken **flexural** strength specimen retained in A-5.

A-8.4 Procedure — Immerse the specimen (in the vial) in the staining solution for 24 hours. Then wash it thoroughly by scrubbing with a toothbrush or wash it in an ultrasonic cleaner in clean denatured spirit for 15 seconds.

A-8.4.1 Examine all the outer surfaces for staining.

APPENDIX B

(*Clause 6.1*)

SAMPLING OF DENTAL PORCELAIN

B-1. GENERAL REQUIREMENTS OF SAMPLING

B-1.0 In drawing, preparing, storing and handling test samples, the precautions and directions given in B-1.1 to B-1.7 shall be observed.

B-1.1 Samples shall not be taken in an exposed place.

B-1.2 The sampling instrument shall be clean and dry.

B-1.3 Precautions shall be taken to protect the samples, the material being sampled, the sampling instrument and the containers for samples from adventitious contamination.

B-1.4 To draw a representative sample, the contents of each container selected for sampling shall be mixed as thoroughly as possible by suitable means.

B-1.5 The samples shall be placed in clean, dry, air-tight glass or other suitable containers.

B-1.6 The sample containers shall be of such size that they are almost completely filled by the sample.

B-1.7 Each sample container shall be sealed air-tight with a suitable stopper after filling, and marked with full details of sampling, the date of sampling, and the year of manufacture of the material.

B-2. SCALE OF SAMPLING

B-2.1 Lot — All the containers in a single consignment of the material of the same shade, same type, and drawn from a single batch of manufacture shall constitute a lot. If a consignment is declared or known to consist of different batches of manufacture, the containers belonging to the same batch shall be grouped together and each such group shall constitute a separate lot.

B-2.1.1 Samples shall be tested from each lot for ascertaining conformity of the material to the requirements of this specification.

B-2.2 The number of containers (n) to be selected from the lot shall depend on the size of the lot (N) and shall be as given in Table 2 subject to the provision that if n containers do not provide sufficient material for carrying out all the tests specified in 4 then at least as many containers as will provide sufficient material shall be taken out.

TABLE 2 NUMBER OF CONTAINERS TO BE SELECTED FOR SAMPLING

LOT SIZE	NUMBER OF CONTAINERS TO BE SELECTED
N	n
(1)	(2)
3 to 50	3
51 ,, 200	4
201 ,, 400	5
401 ,, 650	6
651 ,, 1 000	7

B-2.2.1 These containers shall be selected at random. In order to ensure the randomness of selection procedure given in IS:4905-1968* may be followed.

B-3. PREPARATION OF TEST SAMPLES AND REFEREE SAMPLE

B-3.1 If each of the samples taken from a lot in accordance with B-2.2 is found to comply with visual requirements given in 4, the lot shall be further examined for other characteristics given in 4.

B-3.2 From each of the samples selected from the same lot under B-2.2 approximately equal but small quantity of material shall be taken and thoroughly mixed to form a composite sample of quantity sufficient to make triplicate determinations for each of the characteristics tested on the composite sample.

***Methods for random sampling.**

B-3.3 The composite sample shall be divided into three **equal** parts, one for the purchaser, another for the supplier and the third for the referee.

B-3.4 The composite sample shall be transferred to suitable sample container.

B-3.5 **Referee Sample** — The referee sample shall consist of one of the parts of the composite sample marked for this purpose and shall bear the seals of the purchaser and the supplier. It shall be kept at a place agreed to between the purchaser and the supplier and shall be used in case of dispute.

B-4. NUMBER OF TESTS

B-4.1 Tests for all the characteristics, except visual, given in 4 shall be conducted on the composite sample.

B-5. CRITERIA FOR CONFORMITY

B-5.1 A lot shall be declared as conforming to this specification if the composite sample satisfies the requirements for each of the characteristics tested on composite sample. If the requirements are not met, the lot shall be declared to have not satisfied the requirements of the specification.